

10/538326

(12) INTERNATIONAL PUBLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



538326

(43) International Publication Date  
24 June 2004 (24.06.2004)

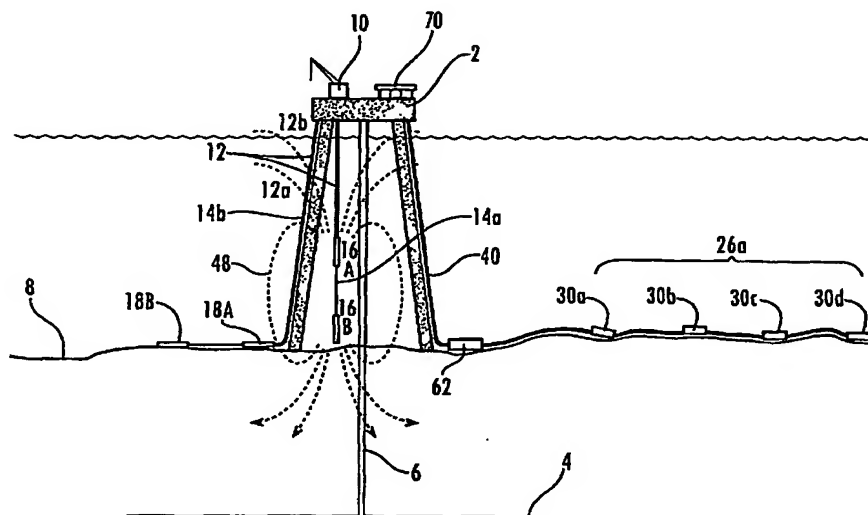
PCT

(10) International Publication Number  
**WO 2004/053528 A1**

- (51) International Patent Classification<sup>7</sup>: **G01V 3/12**
- (21) International Application Number:  
PCT/US2003/039309
- (22) International Filing Date:  
10 December 2003 (10.12.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
60/432,467 10 December 2002 (10.12.2002) US
- (71) Applicant (for all designated States except US): **THE REGENTS OF THE UNIVERSITY OF CALIFORNIA** [US/US]; 1111 Franklin Street, 5th Floor, Oakland, CA 94607 (US).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **CONSTABLE, Steven, C.** [US/US]; 5295 Bothe Ave., San Diego, CA 92122-4018 (US).
- (74) Agents: **MUSICK, Eleanor, M.** et al.; Procopio Cory Hargreaves & Savitch LLP, 530 B Street, Suite 2100, San Diego, CA 92101-4469 (US).
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (*regional*): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:  
— with international search report

[Continued on next page]

(54) Title: **SYSTEM AND METHOD FOR HYDROCARBON RESERVOIR MONITORING USING CONTROLLED-SOURCE ELECTROMAGNETIC FIELDS**



(57) Abstract: The system and method for real-time monitoring of a hydrocarbon reservoir (4) during extraction include an electromagnetic source assembly (16) for transmitting a first plurality of electromagnetic fields. A plurality of seafloor antennae (30a-30d) is distributed over an area of the seafloor (8) corresponding to the reservoir (4), where each antenna (30a-30d) comprises a receiver electrode array (30a-30d) adapted for receiving a second plurality of electromagnetic fields and generating signals corresponding to the detected fields. A data logging processor receives the signals over time and stores data corresponding to the signals. Different combinations of the receiver electrode are used in combination with transmitter antennae for measuring vertical, radial and/or azimuthal fields. Transmission and detection of the fields can be performed continuously or at timed intervals during hydrocarbon extraction to estimate the rate and efficiency of extraction.

WO 2004/053528 A1



— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/39309

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G01V 3/12

US CL : 324/337

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 324/337, 334, 338, 347, 354; 175/45; 73/152.02, 152.03, 152.05, 152.06; 166/250.02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
EAST Geophysics Database

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,617,518 A (SRNKA) 14 October 1986 (14.10.1986), Figure 1.	1-29
A	US 3,052,836 A (POSTMA) 04 September 1962 (04.09.1962), Figure 1.	1-29
A	US 2,531,088 A (THOMPSON) 21 November 1950 (21.11.1950), Figure 1.	1-29
A	US 5,770,945 A (CONSTABLE) 23 June 1998 (23.06.1998), Figure 3.	1-29
A	US 4,634,804 A (SPALDING) 06 January 1987 (06.01.1987), Figure 1.	1-29

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

11 May 2004 (11.05.2004)

Date of mailing of the international search report

24 MAY 2004

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US

Commissioner for Patents

P.O. Box 1450

Alexandria, Virginia 22313-1450

Facsimile No. (703) 305-3230

Authorized officer

Jay M. Patidar

Telephone No. (571) 272-2265

*Patidar*